Space Weather Technical Forecast

Issued on Thursday, 09 May 2024 at 00:31 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further X-class flares (R3 - Strong radio blackouts) likely. Chance of G2-G3/Moderate-Strong geomagnetic storm conditions on 10 May.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been High with six sunspots on the visible disc. AR3663 in the northwest and AR3664 in the southwest have both produced frequent M-class flares during the period, as well as each an X1.0 flare; at 08/0141 UTC from AR3663 and 08/0509 UTC from AR3664. AR3664 also produced a long duration M-class flare, peaking at M9.98 at 08/2140 UTC. This region is approaching the western limb, making analysis of its magnetic structure difficult. It appears to retain a delta configuration, although has seen a recent slight decline in penumbral extent and spot number. AR3664 remains by far the largest region on the disc and comprises a number of strong spots, with compact penumbra, along with several delta spot configurations. Previous region AR3668, which lay to the east of AR3664, has now amalgamated into AR3663. The remaining sunspots on the disc are smaller, stable and magnetically simple.

A large filament erupted in the northeast quadrant, starting around 08/1807 UTC. This is produced a CME which may have an Earth directed component. The long duration M-class flare, that occurred late in the day from AR3664, is likely to have produced a CME which would be expected to be Earth directed. Analysis of both CME's will be undertaken once suitable imagery is available.

A 'full-halo' CME associated with the long duration X1.0 flare of AR3664 at 08/0509 UTC has been analysed, with an expected arrival time either late tomorrow (10th May) or more likely early day 3 (11th). This CME is caught by a faster, later, CME from the M8.8 flare from AR3664, creating a more substantial CME arrival.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 started at elevated levels but then declined to slightly elevated levels as the connection to the HSS of CH35/+ continued to ease. Speeds peaked at 548km/s at 08/0256 UTC. Density remained below average throughout the period. The Interplanetary Magnetic Field, Bt, persisted at weak levels with peaks of 4nT at times through the morning. The north-south component, Bz, varied weakly between +3/-3nT. Phi angle remained positive (away from the sun). Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was mostly at normal background levels, although indicated occasional very minor responses to the flare activity. High energy electron flux (greater than 2MeV) observed at GOES16 remained at largely background levels. The associated 24-hour fluence was well below the Active threshold. Observed fluence at 09/0001 UTC was 7.96e6 integrated pfu on an upward trend.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: High solar activity is expected to continue, with frequent M-class flares and isolated X-class flares likely throughout, principally from AR3664. New regions may also rotate onto the visible disc to contribute towards flare activity, just as AR3663 rotates behind the west limb.

Solar Wind / Geomagnetic Activity: There are several potential Earth-directed CMEs in the forecast period. There is a slight chance for a couple of glancing impacts early on today (9th May) and also on tomorrow (10th May). A more significant CME is expected to arrive either late tomorrow (10 May), or more likely early on day 3 (11th).
Earth is under the influence of a slowly declining HSS (High speed stream) from CH35/+ with slightly elevated solar winds expected to fall to background levels by late tomorrow (10th May). Within the past 24 hours a new, small coronal hole has developed in the western hemisphere. if this feature persists then a weak HSS may arrive during day 3 (11th), with slightly elevated wind speeds likely. However, any HSS is likely to be masked by the effects of the significant CME arrival.

Geomagnetic activity probably mostly remaining Quiet to Unsettled through the early guidance period, with a slight chance of Minor Storm (Kp5) intervals today. Activity should increase to G1-G2/Minor-Moderate (Kp 5-6) Storm levels, with a chance of peak G3/Strong (Kp 7) Storm conditions, from late tomorrow or more likely early day 3 (11th). Through day with activity is expected to decline.

Energetic Particles / Solar Radiation: High energy proton flux is likely to remain predominantly at background levels through the period. There is an ongoing chance for an S1/Minor Storm or greater event throughout from AR3663 and AR3664.

High energy electron flux is forecast to be at background to moderate levels throughout, with associated fluence expected to remain well below the Active (1e8 integrated pfu) threshold.

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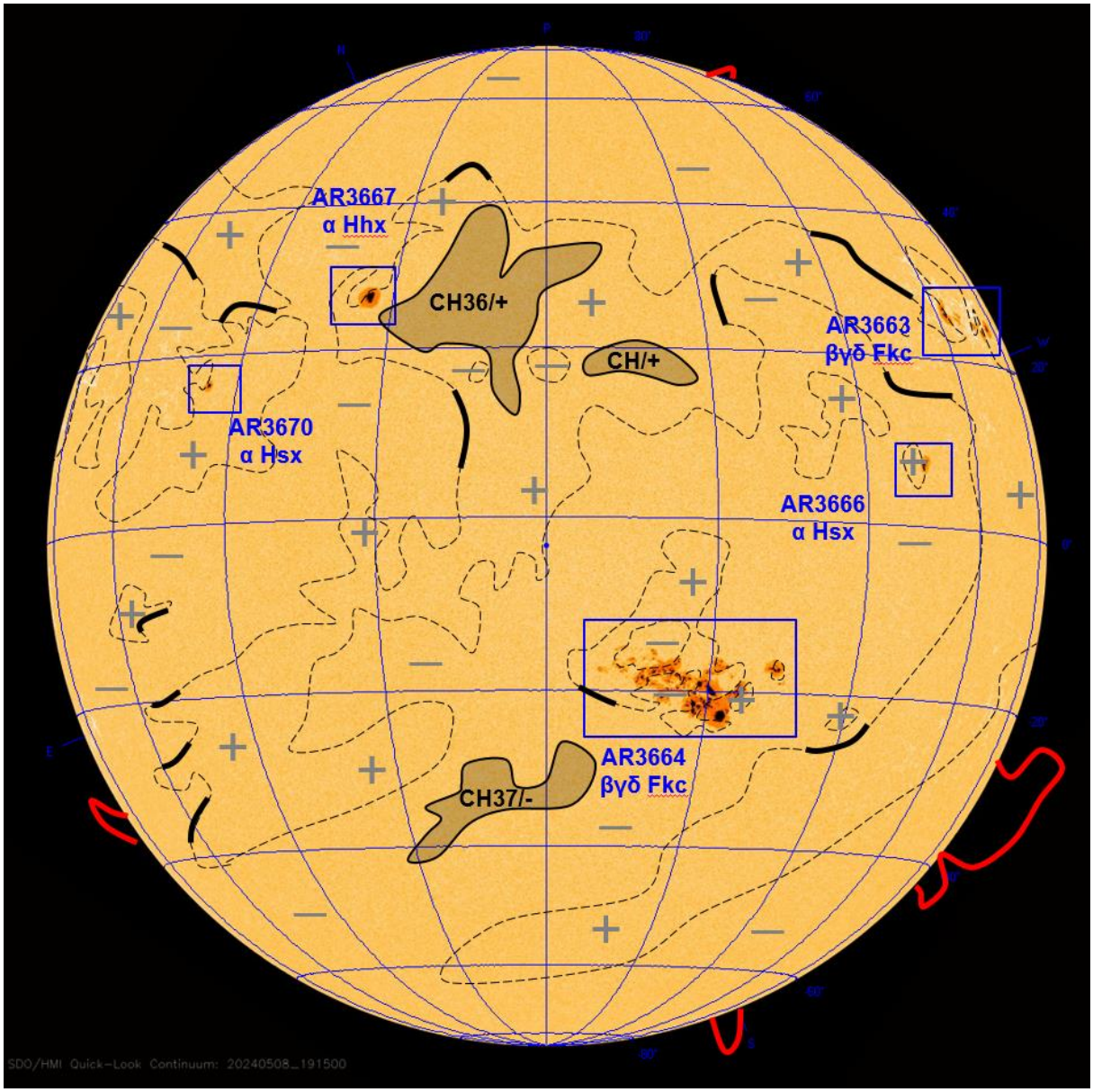
Figure 1. Solar Analysis Valid 08/1915 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are several potential Earth-directed CMEs in the forecast period. There is a slight chance for a couple of glancing impacts early on today (9th May) and also on tomorrow (10th May). A more significant CME is expected to arrive either late tomorrow (10 May), or more likely early on day 3 (11th), generated from combination of the CME's generated by the X1.0 flare that occurred early on 8th May, and the slightly later M8.6 flare, both from AR3664.
Earth is under the influence of a slowly declining HSS (High speed stream) from CH35/+ with slightly elevated solar winds expected to fall to background levels by late tomorrow (10th May). Within the past 24 hours a new, small positive coronal hole has developed in the western hemisphere. if this feature persists then a weak HSS may arrive during day 3 (11th), with slightly elevated wind speeds likely. However, any HSS is likely to be masked by the effects of the significant CME arrival.

Geomagnetic activity probably mostly remaining Quiet to Unsettled through the early guidance period, with a slight chance of Minor Storm (Kp5) intervals today. Activity should increase to G1-G2/Minor-Moderate (Kp 5-6) Storm levels, with a chance of peak G3/Strong (Kp 7) Storm conditions, from late tomorrow or more likely early day 3 (11th). Through day with activity is expected to decline to Unsettled to Active (Kp 3-4) levels, with perhaps the weak influence of the new, small coronal hole preventing geomagnetic activity levels decreasing any further.

Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	5	70	90	40
Strong	G3	No	1	10	40	20
Severe	G4	No	1	1	5	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
06/1056	Partial	AR3663	NW	811 km/s	09/0000	Slight chance of glancing blow
06/0251	Partial l	Filament	SE	323 km/s	10/1200 UTC	Slight chance of glancing blow
08/0927	Full	AR3664	SW	850 km/s	10/1800	Merges with below
08/1200	Partial	AR3664	SW	715 km/s	11/0000	Sig impact

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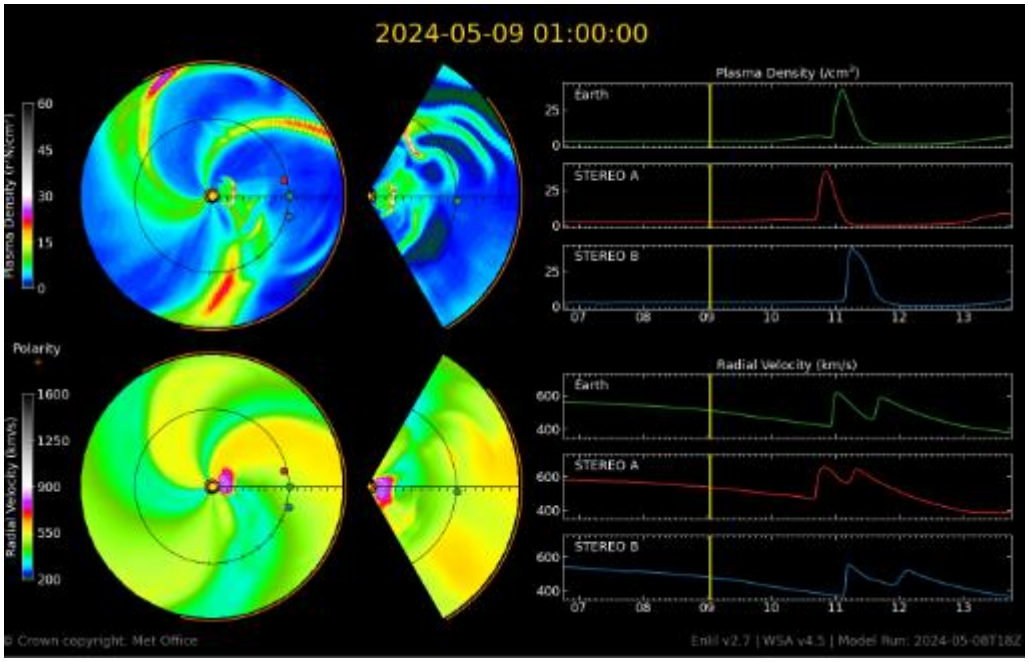
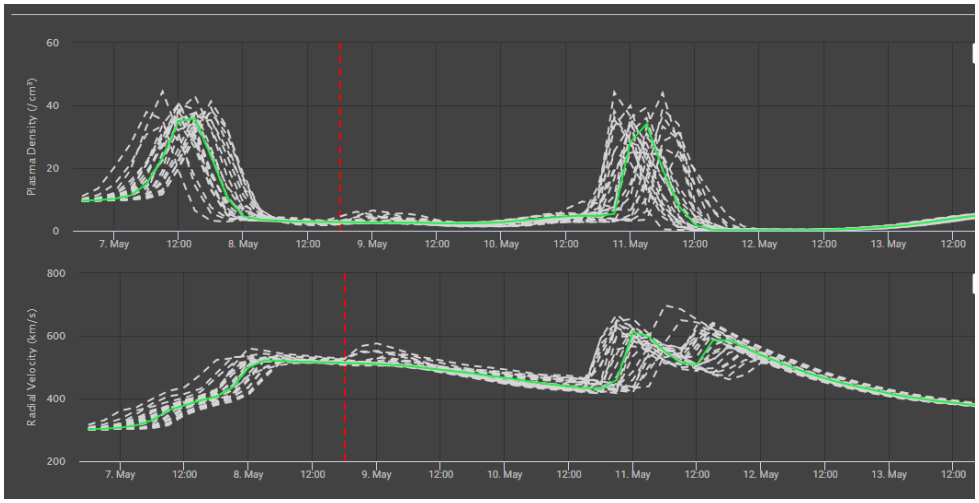
Figure 2: MOSWOC Enlil and Ensembles





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Radio Blackouts - X-Ray Flares:

Solar activity has been High with a X1.0 flare reached at 08/0141 UTC from AR3663, and another X1.0 flare from AR3664 at 08/0509 UTC. A long duration M9.98 flare also occurred at 08/2140 UTC from AR3664, with frequent other M-flares from both regions during the past 24-hour period.
There are six sunspot regions on the visible disc, with a new unnumbered small region in the northeast quadrant fading, and previous AR3668 merging into AR3664. AR3664 remains, by far, the largest and most active flaring region on the disc. Areal extent has increased with consolidation of a number of the smaller spots into the broader penumbra regions as well as comprising of a number of strong spots with significant mixing of its constituent magnetic polarities. This is particularly evident in its intermediate portion and with the region displaying a complex Mt Wilson Beta-Gamma-Delta configuration containing multiple delta spots. The region lies in close proximity to AR3668 to the east, with which it is magnetically connected and hard to distinguish from AR3664. AR3663 remains active with a delta spot configuration, although appears to be waning in size as it approaches the western limb. The remaining sunspots on the disc are smaller, more stable and magnetically simple.
AR3663 is due to rotate over the western horizon on tomorrow (10th May). Far-sided helioseismographs indicate a number of returning regions over the eastern horizon in the coming days that may supplement the present risk of significant flares should they persist.
High solar activity is expected to continue, with frequent M-class flares and isolated X-class flares likely, principally from AR3664 but also initially from AR3663 before the region rotates behind the west imb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	95	95	95	95
Very Active	R3 to R5 X Class	Yes	50	50	50	50

Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV) observed at GOES-18 has been at background levels and is currently likely to remain that way through the period. However, there is a chance of an S1/Minor Storm or greater event occurring on all days, from both AR3663 and AR3664 as they transit the western solar hemisphere. Although recent flares have so far failed to trigger any significant proton response.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)

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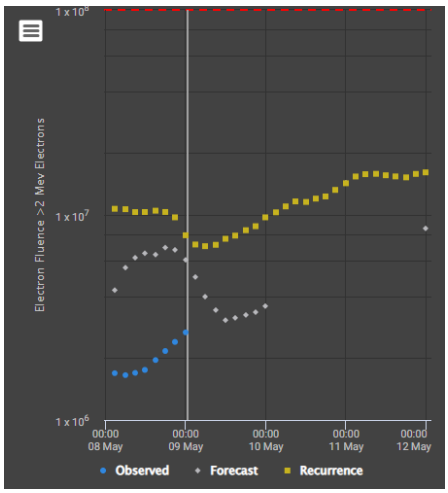
Active	**≥ S1**	No	30	30	25	25
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):
High energy electron flux is at normal background levels. Likely CME and coronal hole influences through the period are expected to limit electron flux to background to moderate levels on all days.
Overall, the 24 hour integrated electron fluence is forecast to remain well below the Active (1e8 integrated pfu) threshold, despite the current upward trend. The Met Office REFM model is therefore considered to be giving good guidance.

GEO Electron Environment	**Level (cm^{-2} sr^{-1} day^{-1})**	**Past 24 Hours (Yes/No)**	**Day 1 (00-24 UTC)**	**Day 2 (00-24 UTC)**	**Day 3 (00-24 UTC)**	**Day 4 (00-24 UTC)**
Probability (Exceedance)			**(%)**	**(%)**	**(%)**	**(%)**
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: MOSWOC REFM model



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